



EMERGING ENERGY TECHNOLOGY FUND

Prospectus
Fall 2018



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EXECUTIVE SUMMARY

The Alaska State Legislature created the Emerging Energy Technology Fund (EETF) in 2010 to promote the expansion of energy sources available to Alaskans. The EETF is a grant program governed by AS 42.45.375 and 3 AAC 107.700 to 3 AAC 107.779. Grants are for demonstration projects of technologies that have a reasonable expectation of becoming commercially viable within five years and; test emerging energy technologies or methods of conserving energy, improve an existing technology, or deploy an existing technology that has not previously been demonstrated in the state. The program has executed three solicitations (2010, 2012, and 2016) and awarded funding to 22 projects from a pool of 106 applicants.

PROGRAM DEVELOPMENT

After the 2008 upsurge in oil prices, the State of Alaska initiated the Renewable Energy Fund (REF) and directed the Alaska Energy Authority (AEA) to administer the fund. The REF Program focuses on funding commercially viable renewable heat and power projects that are technically and economically feasible. Understanding that many new energy technologies could benefit Alaska, the State created the Emerging Energy Technology Fund (EETF) in 2010 and again directed AEA to administer the fund. Since inception, the REF has awarded \$271.8 million in State funds through 287 grants across eight annual solicitations. Grantees committed an additional \$152.1 million in match. These projects have highlighted the need for continued development of energy technologies and architectures to meet the diverse energy needs of Alaska.

PROGRAM FUNDING

The EETF Program may accept money appropriated by the legislature, gifts, bequests, contributions from other sources, including federal money appropriated to the Fund. As of 2018, \$11.85 million has been committed to the Program with \$6.8M coming from State funds and \$5.05M coming from Federal funds. The award recipients and project partners dedicated an additional \$4.7 million.

ELIGIBILITY FOR FUNDING

Technologies tested through the EETF Program include those that promote, enhance, or expand the diversity of available energy supply sources or means of transmission, increase energy efficiency, or reduce negative energy-related environmental effects. This includes technologies related to renewable sources of energy, conservation of energy, enabling technologies, efficient and effective use of hydrocarbons, and integrated systems.

TECHNOLOGY DEMONSTRATION

Data collection and analysis is a central component of all EETF awards and \$1.1 million has been devoted to this effort. Under an agreement with the University of Alaska, the Alaska Center for Energy and Power (ACEP) independently verifies and analyzes performance and other data generated by projects. Summary reports and non-sensitive data are available to the public as projects conclude.

BACKGROUND

The Alaska State Legislature authorized the Emerging Energy Technology Fund (EETF) under AS 42.45.375 “to promote the expansion of energy sources available to Alaskans” and directed the Alaska Energy Authority (AEA) to administer the program. AEA is an independent corporation of the State of Alaska and is the state’s energy office. AEA’s mission is “To Reduce the cost of Energy in Alaska” which places Alaska at the forefront of innovative techniques to address high energy costs. In this vein, and after the 2008 upsurge in oil prices, the State of Alaska initiated the Renewable Energy Fund (REF) and directed AEA to administer the fund. The creation of the EETF Program was, in part, a response to a need identified through the implementation of the REF.

The REF Program focuses on funding commercially viable renewable heat and power projects that are technically and economically feasible. Since inception, the REF has awarded \$271.8 million in State funds through 287 grants across eight annual solicitations. Grantees committed an additional \$152.1 million in match. Many of these projects include cutting-edge technologies and system architectures in remote communities across Alaska. These projects have highlighted the need for continued development of energy technologies and architectures to meet the diverse energy needs of Alaska.

By statute, the EETF Program awards grants for demonstration projects of technologies that have a reasonable expectation of commercial viability within five years. These projects can test emerging energy technologies or methods of conserving energy, improve an existing technology, or deploy an existing technology that has not previously been demonstrated in the state. Eligible technologies include those that promote, enhance, or expand the diversity of available energy supply sources or means of transmission, increase energy efficiency, or reduce negative energy-related environmental effects. This includes technologies related to renewable sources of energy, conservation of energy, enabling technologies, efficient and effective use of hydrocarbons, and integrated systems.

The EETF Program may accept money appropriated by the legislature, gifts, bequests, contributions from other sources, including federal money appropriated to the Fund. As of 2018, \$11.85 million has been committed to the Program with \$6.8M coming from State and \$5.05M coming from Federal funds. The award recipients and project partners dedicated an additional \$4.7 million. Three rounds of EETF Program funding has been completed and the investments to the REF and EETF projects have created a boom in learning and attracted new products, technologies, and companies; all wanting to prove their mettle in Alaska’s harsh environment.

EETF RELEVANCE

Alaska provides unique platforms and opportunities not available in many laboratory or project demonstration settings. The REF and EETF are programs with established procedures, personnel, and, most importantly, demonstrated knowledge and successes. Alaska has many potential sites for deployment both in the number, type, and size of locations and in the geographical, environmental, and energy resource diversity available. The University of Alaska's Alaska Center for Energy and Power has developed their Power Systems Integration Lab and Tanana River Hydrokinetic Test Site along with Data Collection and Management Services to support energy technology projects.

REF projects have a documented economic and environmental benefit to Alaska, displacing 15 million gallons of diesel fuel or equivalent with a value of over \$30 million/annually (based on 2016 costs). These projects have also provided a framework for designing and implementing hybrid power systems. The EETF Program has taken the baton and is testing solutions that may loosen the constraints of this framework. In March of 2015, visitors from around the world attended the first Islanded Grid Resource Center, Wind Power Conference held in Anchorage, Alaska. It was widely recognized at the conference that Alaska was the world leader in islanded, wind-diesel microgrid design and implementation. This recognition of expertise is largely due to the Renewable Energy and Emerging Energy Technology Funds' focus on commercially viable renewable heat and power projects that are technically and economically feasible while simultaneously promoting the expansion of energy sources available to Alaskans.

The EETF is testing solutions that may loosen the constraints of existing diesel hybrid power system design and implementation.

Whether measured by economic, environmental, or research values there have been many successes through the REF and EETF Programs. The Kodiak Electric Association REF project created a hydro-wind-diesel-BESS system that generated 99.7% of their 14 Megawatt average load in 2014 through renewable energy at a consumer rate 2.5% less than 2001. Wind-diesel projects funded through the REF Program have economically reached 30-40% annual average renewable energy penetration levels without the benefit of large balancing areas and economies of scale. These statistics are inspiring; energy projects in Alaska have revealed the bounds of current design and implementation.

It is the mission of the EETF Program to take the next step. EETF projects such as TDX Power's "Diesels-off Flywheel Project" and Chugach Electric Association's "Multi-Stage Energy Storage System" received funding for energy storage solutions and architectures to do just that. The third round of awarded projects are now gearing up to respond to the evolving needs of energy stakeholders.

HOW IT WORKS

APPLICATION AND AWARD PROCESS

Project selection for the EETF program uses a two-stage application process and a volunteer advisory committee appointed by the governor. In the first stage, the advisory committee and the Alaska Energy Authority reviews project abstracts submitted in response to a funding solicitation. Select applicants are invited to submit full applications and give in-person presentations to the committee. Applications are scored and ranked on a range of criteria including the quality of the innovation, the method of validation, and the public benefit and market potential for the proposed technology. Priority is given to projects demonstrating potential for widespread deployment, partnerships with post-secondary institutions, Alaska entities, projects committing in-kind or matching funds, and alignment with any focus identified in the solicitation.

In 2012, over \$8 million in grants were awarded to 15 projects in Round 1 of the EETF. A matching contribution by the Denali Commission, a federal agency, nearly doubled the state funds available for awards. A wide range of technologies were selected for funding, including energy storage, end-use efficiency, biomass, wind generation, and river hydrokinetics. In 2014, Round 2 of the EETF Program focused on energy storage and heating efficiency and five projects were awarded \$2 million from the State of Alaska. In 2016, Round 3 of the EETF, which included a \$250,000 grant from the Department of Energy, focused on microgrid and microgrid enabling technologies and awarded funding to two projects.

PROGRAM HIGHLIGHTS

- Nineteen demonstration projects were awarded grants over two funding rounds from an applicant pool of nearly 100
- Funded projects include energy storage, wind-diesel integration, and space heating technologies – all key areas of focus in Alaska
- Field deployments of three different in-river hydrokinetic devices each successfully generating electricity
- Diesels off operation of two remote wind-diesel power grids using battery and flywheel energy storage systems
- Continued development of in-state technologies, including: building efficiency, power electronics, and diesel generation efficiency
- Use of technology testbeds made available by the University of Alaska for power systems integration and hydrokinetic testing

PROJECT SUCCESSES

- New Exhaust Thimbles have been tested and yielded excellent results. The grantee is now beginning the patent process with plans to commercialize
- The EETF Program has led to multiple successes with in-situ hydrokinetic devices that have advanced technology in “run of the river” hydro power by leaps and bounds. These successes are moving towards Commercialization (see ORPC RivGen and BRI Cyclo-Turbine)
- Biomass Reforestation is paving the way towards a greener, more sustainable future for biomass systems in Alaska

FUNDING PROJECTS' STATUS

	<u>Funded EETF Projects</u>	<u>Project Lead</u>	<u>Round</u>
1	Air Source Heat Pump Potential in Alaska	Cold Climate Housing Research Center	2
2	Application of Composite Flywheels	Hatch	1
3	Arctic Field Testing the Eocycle 25/12 Wind Turbine	Northwest Arctic Borough	1
4	Arctic Thermal Shutters & Doors	Arctic Sun, LLC	1
5	Biomass Reforestation for Boreal Forests	Alaska Division of Forestry	1
6	BRI Cyclo-Turbine Hydrokinetic Demonstration	Boschma Research, Inc.	1
7	Cold Climate Heat Pump Demonstration	Cold Climate Housing Research Center	1
8	Enhanced Condensation for Organic Rankine Cycle	UAF – Inst. of Northern Engineering	1
9	High Capacity Airborne Wind Turbine	Altaeros Energies, Inc.	1
10	High Efficiency Diesel Electric Generator Set	Marsh Creek	1
11	Multi-Stage Energy Storage System	Chugach Electric Association	2
12	Oceana In-Stream Hydrokinetic Demonstration	Oceana Energy Company	1
13	RivGen Power System Hydrokinetic Demonstration	Ocean Renewable Power Company	1
14	Safe and Efficient Exhaust Thimble	UAF – Inst. of Northern Engineering	1
15	Small Community Self-Regulating Grid	Intelligent Energy Systems	1
16	St Paul Flywheel Demonstration	TDX Power	2
17	Trans-Critical CO2 Heat Pump System	Alaska SeaLife Center	2
18	Ultra-Efficient Generators and Diesel-Electric Propulsion	Genesis Machining & Fabrication	1
19	Wind-Diesel Battery Hybrid for Kwigillingok	Intelligent Energy Systems	1

1. Air Source Heat Pump Potential in Alaska

EETF Recipient & Project Lead:	Cold Climate Housing Research Center 955 Draanjiik Drive Fairbanks, AK 99775 907-457-3454
Project Start, Completion:	April 2014 – February 2016
Project Location:	Juneau, Wrangell, Dillingham, Alaska
Project Scope:	CCHRC demonstrated the performance of a new generation of air-source heat pumps (ASHP) in an effort to provide energy efficient space heating for Alaska's cold climates and better define the potential geographic range for economic operation of ASHP technology.
Project Status:	CCHRC instrumented three ASHP installations in order to determine performance over the 2014-2015 heating season. Cold Climate Housing Research Center, University of Alaska Fairbanks Bristol Bay Campus and Wrangell Municipal Power and Light were the three principal project partners. An additional 30 heat pump installations were also monitored through a utility billing analysis and by interviewing building occupants about their satisfaction with the technology.
Project Outcomes:	The direct monitoring of three cold climate ASHPs revealed that the installed performance could differ significantly from the manufacturer specifications for efficiency. Furthermore, results from this study and those from prior studies have shown that the efficiency differences between brands can differ enough that they should not be viewed as interchangeable products. Despite these distinctions, the vast majority of the 30 heat pump users interviewed were satisfied with them. Cold climate ASHPs should reduce electricity use by displacing electric heat, and should increase electricity use when displacing oil heat. However, this study found variability of the actual changes in energy use across the small sample of monitored retrofit installations. The culmination of the data collection effort and analyses performed under this grant is a report (dated 12-31-2015) entitled, <i>"Air Source Heat Pump Potential in Alaska."</i>
Additional Information:	http://www.cchrc.org/air-source-heat-pump-potential-alaska

2. Application of Composite Flywheels

EETF Recipient & Project Lead:	Hatch Associates Consultants Inc. address address 905-855-7600
Project Start, Completion:	July 2012 – March 2015
Project Location:	Fairbanks, Alaska
Project Scope:	Hatch demonstrated a lightweight high-power flywheel to provide grid stability in wind-diesel systems.
Project Status:	The project team collected one month of high-resolution baseline data from Nome's wind-diesel system that was used in modelling and controller programming. The flywheel was installed in a simulated grid at the Alaska Center for Energy and Power's Power System Integration lab in Fairbanks for a series of trials that characterized the response of the flywheel system and its ability to support the grid using the lab's grid-forming inverter.
Project Outcome:	In the laboratory setting, the flywheel demonstrated the capacity to stabilize system frequency and voltage excursions, protect the system from sudden loss of wind power production, and transition from diesel's-on to diesel's-off modes. The tests are complete and the project team has compiled a final project report. An independent report assessing performance has been completed by the Alaska Center for Energy and Power.
Additional Information:	HYPERLINKS HERE

3. Arctic Field Testing of the Ecocycle EO-25/12 Wind Turbine

EETF Recipient & Project Lead:	Northwest Arctic Borough address address phone
Project Start, Completion:	August 2012 – June 2017
Project Location:	Kotzebue, Alaska
Project Scope:	The Northwest Arctic Borough is demonstrating the cold weather capabilities of a 25-kilowatt, Ecocycle wind turbine at the Kotzebue wind farm. The turbine is mounted on a tilt-up monopole tower that uses a winch to raise and lower the unit during installation and for maintenance, eliminating the need for a crane. There are limited options for turbines of this size and, combined with the tilt-up tower and transmission less design, it may be a viable options for Alaska communities with small electrical loads.
Project Status:	The turbine and tilt-up tower arrived at Kotzebue on the last barge of 2013 and the project team used an existing unused tower foundation to the mount the turbine. Commissioning began in late 2013 and continued for the next year with extensive troubleshooting as numerous problems were encountered including overheating in the nacelle, a problem with the brake assembly shutting down the turbine, converter failure and data/communication issues. The turbine was fully operational in November 2014. In September 2015, the connection between the rotor and the generator ruptured; the turbine was repaired in May 2016 and is currently operational. These issues were primarily due to the turbine being a beta model and problems of these kinds can be expected in a product development cycle.
Continuing Activities:	Wind turbine operational data was collected from the turbine and a nearby metrological station through the higher winds of the 2016-2017 winter. A final report is being prepared.
Additional Information:	HYPERLINKS HERE

4. Arctic Thermal Shutters and Doors

EETF Recipient & Project Lead:	Arctic Sun, LLC address address phone
Project Start, Completion:	August 2012 – September 2015
Project Location:	Fairbanks, Alaska
Project Scope:	Arctic Sun demonstrated improved insulation of arctic doors, mechanized exterior shutters, and shutters for retrofitted fixed-panel windows in an effort to alleviate indoor condensation issues and increase the efficiency of arctic homes.
Project Status:	The activities conducted for this grant included designs and construction of the Arctic Door, arctic shutters, and a Blown-In Insulated Shutter. Two rigid shutter systems were developed, instrumented and tested. The Blown-In Insulated Shutter was developed and installed at a field test facility. Performance of the shutter systems was evaluated by ACEP using the temperatures measured and recorded at the interior and exterior of the surfaces of the window glass and shutters.
Project Outcomes:	The Arctic Door was successfully designed and constructed and has become a product manufactured locally (Great Land Windows) and available in the Alaska marketplace. The two prototype Arctic Shutters were tested and found to be effective in reducing heating costs, though the construction using wood stiles did not perform as well as the shutters constructed without wood. A prototype Blown-In Insulating Shutter was constructed and operationally tested at one field location outside of Fairbanks. The blown-in insulation system has some operational challenges which need to be overcome to effectively insulate non-opening windows. The test results are documented in the report: <i>Insulating Thermal Shutters for Arctic Building Applications – A project by Arctic Sun, LLC by Alaska Center for Energy and Power (ACEP)</i> .
Additional Information:	HYPERLINKS HERE

5. Biomass Reforestation of Boreal Forests

EETF Recipient & Project Lead:	Alaska Division of Forestry address address phone
Project Start, Completion:	August 2012 – December 2016
Project Location:	Palmer and Delta Junction, Alaska
Project Scope:	The Alaska Division of Forestry and the Forest Products Program at UAF investigated a low cost planting technique intended for forest regeneration after biomass harvest that uses un-rooted poplar tree stem-cuttings. This study compared the growth and survival of hybrid poplar varieties to that of the native balsam poplar found in Alaska.
Project Status:	In March 2013, the project team harvested over 4,000 cuttings of poplar (<i>P. trichocarpa</i>) growing in Palmer and balsam poplar (<i>P. balsamifera</i>) from Delta Junction; poplar whips were obtained from Canada (<i>P. balsamifera</i> L. from near Edmonton, Alberta; and “Northwest” hybrid poplar <i>Populus x jackii</i> Sarg. from near Edmonton, Alberta). Both the cuttings and whips underwent a 5-7 day pre-soak treatment in advance of planting in the late spring at 10 previously logged upland sites in the Matanuska-Susitna Valley (5) and near Delta (5), as well as two UAF sites. Survival and height was assessed after two growing seasons.
Project Outcome:	Significant differences in survival and height were found, with <i>Populus x jackii</i> having the highest survival, followed by the Alberta <i>P. balsamifera</i> L. <i>P. balsamifera</i> L. from Delta Junction, had lowest survival and height growth. The overall survival at the end of the second growing season was 47%. The Northwest hybrid poplar had the highest survival (69%) followed by balsam poplar from Alberta (56%). Comparing interior Alaska vs. Southcentral Alaska planting sites, the ranking of varieties was the same for planting regions. Differences in height at the end of the second growing season were less clear. Although height growth did yield significant differences among varieties, height growth at 2 years did not provide insights into forest establishment or future forest growth. The performance of the “Northwest” hybrid poplar is noteworthy. “Northwest” hybrid poplar reportedly contains <i>P. balsamifera</i> parentage, which may provide greater cold tolerance.
Additional Information:	HYPERLINKS HERE

6. BRI Cyclo-Turbine Hydrokinetic Demonstration

EETF Recipient & Project Lead:	Boschma Research, Inc. address <u>address</u> phone
Project Start, Completion:	August 2012 – November 2014
Project Location:	Igiugig, Alaska
Project Scope:	Boschma Research, Inc. (BRI) demonstrated a 5 kW River In-Stream Energy Conversion (RISEC) device in the Kvichak River at Igiugig. The cycloidal turbine is housed within an open-ended venturi enclosure with a fish/debris guard at the entrance. Intended to be mounted on the river bottom in shallow water, the device's frame uses buoyancy chambers for river transport that are filled with water to submerge the device to its final position.
Project Status:	The turbine was constructed in 2013 and deployed in the Kvichak River in the summer of 2014. The project team experienced numerous difficulties maneuvering the device in the swift moving water; once positioned, moored, and sunk in place, the anchor slipped causing damage to the housing and communications cables. Ultimately, the device was able to operate, generate approximately 4.5-5kW of power that was fed directly into the Igiugig grid for 36 continuous hours towards the end of the permitted period. The project team has submitted a final project report.
Project Outcome:	An independent report assessing performance was completed by the Alaska Center for Energy and Power. With testing and analysis complete, BRI is exploring commercialization options on an international level.
Additional Information:	HYPERLINKS HERE

7. Cold Climate Heat Pump Demonstration

EETF Recipient & Project Lead:	Cold Climate Housing Research Center address <u>address</u> 907-457-3454
Project Start, Completion:	September 2012 – October 2017
Project Location:	Fairbanks, Alaska
Project Scope:	This project installed a Ground Source Heat Pump (GSHP) at the Cold Climate Housing Research Center's research and testing facility in Fairbanks in a narrow band of thawed ground. Several different surface treatments were modeled and tested to maximize surface heat capture during summer months and to prevent winter heat loss.
Project Status:	The horizontal loop field was installed and buried in late 2013 along with a network of thermocouples at varying depths from the ground surface to approximately 12 feet. The heat pump unit was then installed and fully commissioned in 2013. Different surface treatments were installed above selected areas of the ground loop including dark gravel, sand and grass. A fence was installed around the area to minimize snow compaction and maximize wintertime insulation. Four years of the system performance data have been collected and analyzed. The final report, <i>Ground Source Heat Pump Demonstration in Fairbanks, Alaska</i> , was completed in October 2017 where the performance of the heat pump system was analyzed and documented.
Project Outcome:	The efficiency of the heat pump varied over the course of each heating season. It tended to be higher in the fall when the GHE was the warmest and decrease over the course of the winter. The annual COP and (associated electric cost) of the heat pump and the circulation pumps for the 4 years of operation was 3.69 (\$890), 3.34 (\$1,445), 3.01 (\$1,666) and 2.82 (\$2,360). The annual COP declined 24% over this 4 year period. The results of the operation of the GSHP system were that the savings in operating the GSHP over what the heating needs for the building using conventional stove oil in a 96% efficient boiler were highly dependent on the price of the stove oil. For heating seasons 1 and 2 (price of stove oil = \$4.00/gal), the computed savings were \$604 and \$639 respectively, while in heating seasons 3 and 4 (oil price @ \$2.35/gal), operating the GSHP system cost \$207 more and \$328 more (respectively) than the cost of using oil heat.
Additional Information:	HYPERLINKS HERE

8. Enhanced Condensation for Organic Rankine Cycle

EETF Recipient & Project Lead:	University of Alaska Fairbanks Institute of Northern Engineering address <u>address</u> phone
Project Start, Completion:	August 2012 – December 2016
Project Location:	Fairbanks, Alaska
Project Scope:	The Institute of Northern Engineering at the University of Alaska Fairbanks demonstrated a technology that could improve the efficiency of Organic Rankine Cycle (ORC) systems by increasing the heat transfer rate of the condenser. A hydrophobic coating was patterned onto the condenser to create a heterogeneous surface, reducing film formation on the condensing surface.
Project Status:	The project team completed design and construction of a testing apparatus that was used to measure the efficacy of the hydrophobic coating that was used to give the condenser a heterogeneous surface. Instrumentation calibration and preliminary baseline testing of the apparatus revealed an issue with leaking. The leaks were identified, repaired, and performance data was collected. The final report is available.
Project Outcomes:	The project determined that the proposed condensing surface outperformed a non-treated condensing surface and the angle of the stripes that formed by the design of the heterogeneous condensing surface is a key factor. The proposed condensing surface exceeded the set goal but in a limited sub-cooling range.
Additional Information:	HYPERLINKS HERE

9. High Capacity Airborne Wind Turbine

EETF Recipient & Project Lead:	Altaeros Energies, Inc. address <u>address</u> phone
Project Start	March 2013 / project ended w/o completion due to denial of FAA to issue permit
Project Location:	Healy, Alaska
Project Scope:	Altaeros Energies, Inc. proposed to demonstrate a 30-kilowatt wind turbine suspended 1,000 feet above ground in a helium-filled shell. The project sought to take advantage of higher and more consistent wind speeds and to demonstrate an improved capacity factor relative to tower-mounted wind turbines.
Project Status:	Work began on this grant in 2013 with Eva Creek (near Fairbanks) selected as the deployment site. Testing was completed in Maine on the preliminary performance of inflatable shell (without the wind turbine) in a wind tunnel and in a water tunnel, as well as modifications to the docking trailer. In 2013, the flight platform was test flown for a significant number of days (w/o turbine) to prove and refine some of the details of the Buoyant Airborne Turbine (BAT). Other flight platform testing was conducted in 2015 and 2016 utilizing more conventional teardrop-shaped aerostats. In 2014, Altaeros found the Federal Aviation Administration (FAA) was unable to permit the project due to the prospective testing site's proximity to a nearby non-operational airstrip. Due to the delay in FAA permitting, AEA and Altaeros mutually decided to discontinue the project.
Continuing Activity:	Data collected from preliminary testing has been documented in a final report prepared by the grantee entitled: <i>High Capacity Wind Turbine – Altaeros Energies</i> .
Additional Information:	HYPERLINKS HERE

10. High Efficiency Diesel Electric Generator Set

EETF Recipient & Project Lead:

Marsh Creek, LLC.
address
[address](#)
phone

Project Start, Completion: August 2012 – December 2016

Project Location: Anchorage, Alaska

Project Scope: Marsh Creek demonstrated the use of a permanent magnet “soft clutch” coupling in a diesel genset to facilitate engine operation at speeds of both 1200 and 1800 rpm. This “variable speed” diesel gen-set could potentially operate at a lower rotational speed when power demand is low and significantly improve fuel efficiency.

Project Status: The project team modelled performance, designed the system architecture, and constructed a prototype. Baseline efficiency testing was conducted at 1200 and 1800 rpm, but excessive mechanical vibration prevented complete testing of the transition between the speeds. The team has since designed a solution to the vibration issues. A final report is available.

Project Outcomes: The project determined that significant fuel efficiency gains are possible when the generator was operated at 10%-50% of rated power. However, at higher loads, the additional mechanical components negate the efficiency gains. Overall efficiency improvements are not feasible at the current state of technology.

Additional Information: [**HYPERLINKS HERE**](#)

11. Multi-State Energy Storage System

EETF Recipient & Project Lead:	Chugach Electric Association address <u>address</u> phone
Project Start, Completion:	December 2014 – December 2018
Project Location:	Anchorage, Alaska
Project Scope:	Chugach Electric Association proposed to use a pilot-scale energy storage system to demonstrate the technical and economic viability of a staged flywheel/battery response to grid instabilities. The flywheel would potentially respond to short-term energy fluctuations and the batteries would provide medium term energy storage to accommodate changes in wind production (i.e. ramp rates). The pairing of these two technologies could potentially extend the lifetime of the batteries that is negatively impacted by short-term energy fluctuations and provide the “smoothing” of variable renewable production difficult to obtain with a flywheel. A full-scale system could assist in integrating additional wind power into Alaska’s primary electrical grid in coordination with existing conventional hydroelectric and fossil fuel resources.
Project Status:	A schedule and scope of work were negotiated and the grant was executed in 2014. Quotes received through an RFP caused a delay in the project and an amended RFP was published. The initially selected flywheel manufacturer pulled out of the flywheel manufacturing business. Chugach Electric Association decided to increase their contribution by \$1.775 Million that allowed another manufacturer with a larger flywheel to be selected. Contracts for the design, construction, and construction are being negotiated.
Continued Activity:	Continued procurement of electrical components and installation of the system.
Additional Information:	HYPERLINKS HERE

12. Oceana In-Stream Hydrokinetic Demonstration

EETF Recipient & Project Lead:	Oceana Energy Company address <u>address</u> phone
Project Start, Completion:	August 2012 – January 2018
Project Location:	Nenana, Alaska
Project Scope:	Originally intended for tidal power applications, Oceana Energy Company demonstrated its barge-mounted River In-Stream Energy Conversion (RISEC) device in the Tanana River at ACEP's Hydrokinetic Testbed Facility and is performing additional testing at ACEP's Power Systems Integration Lab in Fairbanks.
Project Status:	The project team completed a redesign of the first generation prototype (built and tested prior to this project), constructed a unit for testing, and performed tow testing to establish a performance baseline in the Carderock David Taylor Model Basin in Maryland prior to shipping the unit to Alaska. Next, the unit was deployed from a testing barge at the Alaska Hydrokinetic Testbed Facility located in the Tanana River at Nenana. The unit was operated in the summers of 2015 and 2016 over the course of two weeks, dissipating power to an onboard load bank.
Continuing Activities:	The unit was further tested at the ACEP test lab late in 2017. Electrical characterization tests were conducted to collect data on the operation of the unit integrated with a simulated microgrid, that provided for varying load conditions and auxiliary diesel genset operation. This allowed for a more accurate model for future development. Oceana has documented its field testing activities and results in a final report entitled: <i>Oceana In-Stream Hydrokinetic Device Evaluation</i> .
Additional Information:	HYPERLINKS HERE

13. RivGen Power System Hydrokinetic Demonstration

EETF Recipient & Project Lead:	Ocean Renewable Power Company address <u>address</u> phone
Project Start, Completion:	August 2012 – February 2016
Project Location:	Nikiski and Igiugig, Alaska
Project Scope:	ORPC demonstrated the RivGen hydrokinetic device, a river-bottom mounted River In-Stream Energy Conversion (RISEC) device. The device was deployed on a pontoon support structure, which consisted of a mounting frame resting on buoyancy chambers that can be filled and emptied of air for controlled submerging during deployment and floatation during retrieval.
Project Status:	ORPC tested its first generation hydrokinetic in Eastport, Maine in 2013. It was tested in 2014 at Igiugig in the Kvichak River where it generated up to 13kW. An issue with the inverter prevented synching with the Igiugig micro power grid, however the project team identified additional funding for improvements to the device and for a follow up deployment at Igiugig in 2015. In the 2015 testing at Igiugig, it successfully demonstrated the ability to reliably supply one-third of the electrical power needs of Igiugig and up to one half for a limited time during the evening peak loads.
Project Outcomes:	During the first deployment in Igiugig in 2014, the RivGen generated up to 13-kilowatts and produced 794-kilowatt hours of energy over a cumulative three days of operation. During the second deployment in 2015, the RivGen produced over two megawatt hours of electricity for Igiugig during its 15 days of operation. After completion of the 2015 deployment, the project team prepared a final report entitled: <i>RIVGEN Power System Commercialization Project: Final Report</i> .
Additional Information:	HYPERLINKS HERE

14. Safe and Efficient Exhaust Thimble

EETF Recipient & Project Lead:	University of Alaska Fairbanks, Institute of Northern Engineering address phone
Project Start, Completion:	July 2013 –March 2015
Project Location:	Fairbanks, Alaska
Project Scope:	The Institute of Northern Engineering designed and demonstrated a new ventilated exhaust thimbles for wood stoves, oil-fired furnaces, diesel generators and other high-temperature exhaust-generating sources. Stove thimbles prevent wood framing from igniting from the hot exhaust flues pass through the building envelope. In this project, the traditional thimble will be replaced with one that relies on thermal siphoning for passive cooling. The new design building eliminates heat loss that accompanies traditional thimbles by maintaining integrity of the building's envelope.
Project Status:	The project team completed final design and computational fluid dynamics modeling of the exhaust thimble, modified a conex container for testing, and constructed prototypes of varying sizes. Testing was completed for each prototype size under a range of temperature conditions. The results of the tests and models have been compiled, and commercialization cost estimates have been obtained from local manufacturers.
Project Outcomes:	The testing conducted during this study showed that during the testing conditions replicated in the laboratory with exhaust gas temperatures up to 1000°F, the temperatures where the thimble made contact with building materials stayed below 400°F, the critical temperature at which pyrolysis starts to occur. The test results are documented in the report: <i>Testing of a New Design of a Safe and Efficient Exhaust Thimble</i> .
Additional Information:	HYPERLINKS HERE

15. Small Community Self-Regulating Grid

EETF Recipient & Project Lead:	Intelligent Energy Systems address <u>address</u> phone
Project Start, Completion:	August 2012 – December 2016
Project Location:	Tuntutuliak, Alaska
Project Scope:	Intelligent Energy Systems (IES) proposed to demonstrate a method of electrical grid stabilization using an advanced control system which sends excess wind generation to ceramic electrical heating units (Steffes heaters) in local homes. A distributed network of Steffes heaters in the community were equipped with modified controllers that respond individually to grid frequency, providing grid stability during times of high wind penetration rates.
Project Status:	A modified controller was independently lab tested. Thirty heaters in the community were subsequently retrofitted with the controllers; after initial tests, the controller logic was revisited and improvements identified. Programming revisions to the controller were disseminated to each individual unit in the field. Data collection is complete and a draft report has been produced.
Continued Activity:	The data and report are under review by Alaska Energy Authority and the Alaska Center for Energy and Power.
Additional Information:	HYPERLINKS HERE

16. St. Paul Flywheel Demonstration

EETF Recipient & Project Lead:	TDX Power Address <u>address</u> phone
Project Start, Completion:	June 2014 – June 2017
Project Location:	St. Paul, Alaska
Project Scope:	A flywheel-energy-storage-system manufactured by Beacon Power was integrated into an isolated wind-diesel microgrid at the TDX Power POSS Camp on St. Paul Island. The flywheel was operated to facilitate extended diesels-off electricity generation. The goal of the project was to demonstrate the technology, potentially paving the way towards higher wind penetration rates, increasing the value of the power contributed by renewables into hybrid systems.
Project Status:	After factory acceptance testing, the flywheel was barged to St. Paul, installed, and commissioned in late 2014. The system was operating and collecting data from December 2014 to May 2015 and ample winter winds enabled significant periods of diesels off operation. Frequency regulation is being provided by a load regulating boiler and voltage regulation is provided by a synchronous condenser (both installed and operational prior to the project). The project scope was expanded to incorporate a redesign of the Beacon Power inverter that would allow the flywheel to form the grid and allow more stable diesels off operation. For business reasons, Beacon Power is exiting the flywheel market and will not be completing the grid forming inverter design. The project was reduced to its' original scope as a result. A main bearing failure occurred rendering the flywheel as unusable. Without manufacturer support repair is not advisable.
Continuing Activities:	TDX is preparing a final report.
Additional Information:	HYPERLINKS HERE

17. Trans-Critical CO₂ Heat Pump System

EETF Recipient & Project Lead:	Alaska SeaLife Center address address phone
Project Start, Completion:	July 2014 – November 2017
Project Location:	Seward, Alaska
Project Scope:	A trans-critical CO ₂ heat pump system using seawater as a heat source was installed to provide space heating at the offices and labs of the Alaska SeaLife Center and demonstrate the potential for higher output temperatures (up to 194 deg. F) than is available from heat pumps using synthetic refrigerants (at 130 deg. F). Though these type of systems are rare in the United States (only 15 CO ₂ heat pumps had been installed in the US by 2016) they are popular in Japan and Europe where energy prices are higher. The other benefit that accrues from the use of these heat pumps is that the refrigerant (CO ₂) is relatively benign to the environment compared to conventional synthetic refrigerants. CO ₂ has 1/1400 of the greenhouse gas potency of synthetic refrigerants.
Project Status:	The design of the CO ₂ heat pump system was completed and the units ordered early in 2015 and installation was completed in December 2015. The system provides space heating for the Alaska SeaLife Center, working in conjunction with the building's existing heating system, which uses seawater source heat pumps with a synthetic refrigerant. The Heat Pump system, consisting of four CO ₂ heat pump units, is installed and operating and as-built mechanical drawings have been finished.
Project Outcome:	The system was operating and collecting performance data over the course the 2015-2016 and 2016 -2017 heating seasons. The grantee has prepared a final report of system performance and lessons learned which is entitled: <i>Alaska SeaLife Center Trans-Critical Heat Pump System</i> .
Additional Information:	HYPERLINKS HERE

18. Ultra-Efficient Generators and Diesel –Electric Propulsion

EETF Recipient & Project Lead:	Genesis Machining & Fabrication address <u>address</u> phone
Project Start, Completion:	August 2012 – December 2016
Project Location:	Kodiak, Alaska
Project Scope:	Genesis Machining and Fabrication demonstrated two core technologies, the Power Dense Motor and Universal Modular Inverter Controller, for use in both stationary power generation and propulsion applications. These technologies were concurrently developed and demonstrated in stages using prototypes of increasing size and capacity used to power electric vehicles and gensets of varying sizes. The team hoped to demonstrate that its' approach to variable speed generation and diesel-electric propulsion offered efficiency gains over traditional technologies.
Project Status:	The team first demonstrated the prototype inverter in an electric vehicle testbed by logging over 1,000 Kodiak road miles in the first year. A 15-kilowatt load-matching genset was designed to deliver power via the inverter and built as a proof of concept. Next, work shifted to the design and installation of the prototype inverter in a diesel-electric bus testbed. A 275-horsepower engine served as a power dense generator head and a 50-horsepower motor served as a propulsion motor. Due to external circumstances, the project lost access to lab and testing space and the scope of work was curtailed to eliminate further testing of the equipment and a final report was prepared to detail accomplishments and lessons learned from this project. While the entire proposed scope was not completed, the project team filed for several patents and reached out to potential investors in anticipation of commercialization.
Project Outcomes:	Three technologies were developed under the grant. A low cost Power Dense Motor, Universal Modular Inverter Controller, and Arctic Battery Management System for prismatic lithium cells. While the motor and controller require additional development, initial testing indicates efficiency improvements in generators over portions of the load range. Genesis filed a patent application for the Arctic Battery Management System in 2015.
Additional Information:	HYPERLINKS HERE

19. Wind-Diesel Battery Hybrid for Kwigillingok

EETF Recipient & Project Lead:	Intelligent Energy Systems address <u>address</u> phone
Project Start, Completion:	August 2012 – December 2016
Project Location:	Kwigillingok, Alaska
Project Scope:	Intelligent Energy Systems proposed to demonstrate the use of high-performance lithium ion batteries, similar to those found in some electric vehicles, to provide short-term energy storage in Kwigillingok's wind-diesel electrical system.
Project Status:	A lithium ion battery manufactured for use in electric cars was selected and delivered by barge to Kwigillingok in the fall of 2013. An abnormally warm winter delayed freeze-up and transportation to the installation site. Commissioning, started in 2014, continues as unrelated issues with the wind turbines, diesel generators, and distribution system have presented challenges and delays. The system has been operational since March 2014. A project final report was received in December 2016.
Continuing Activities:	The collected data and the Grantee's final report is undergoing review by AEA and ACEP.
Additional Information:	HYPERLINKS HERE



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